scribes 'The Birds of a Marsh' near Keuka Lake, N. Y. The fifth series of 'Birds and Seasons' is devoted to the birds to be seen and studied in August and September, as noted by contributors from Boston to Stockton, Cal., with suggestions for the season's study and reading.

THE first number of *The Museums' Journal* of Great Britain is issued promptly, and naturally commences with a statement of the objects of the Museums' Association and its journal. The address of the President, Sir William Turner, delivered at the Edinburgh meeting of the Association follows, and this is devoted to the history of 'The Public Museums of Edinburgh.' A sample is submitted of 'A Museum Label,' descriptive of British pottery and as criticism is invited it may be said that it will strike some as rather long, although it is undeniably replete with information. 'Museum Notes,' 'At Home and Abroad,' complete the number.

IN the issue of SCIENCE for April 26, 1901, there was given a somewhat detailed account of a proposed journal for the statistical study of biological problems, suggested by Professor Karl Pearson and Professor E. F. R. Weldon. We are glad to learn that the first number of the journal, which is called *Biometrika*, will be published in October. Professor C. B. Davenport, of the University of Chicago, is one of the editors, the others being Professors Pearson and Weldon. The journal will be published by the Cambridge University Press and will appear about four times a year. The following papers are ready or in preparation:

'Biometry': FRANCIS GALTON.

'On the Terminology and Notation of Biometric Investigations.'

'Variationsstatistische Probleme und Materialien': Professor Dr. F. LUDWIG.

'Criminal Anthropometry and the Identification of Criminals': Dr. W. R. MACDONELL.

'Critical Bibliography of Statistical Memoirs. I. Heredity': Professor W. F. R. WELDON.

'Anthropometric Data from Australia': W. POWYS.

'Variations in *Synapta inhærens*': Professor C. L. EDWARDS.

'Homotyposis in the Egg of the House-Sparrow': Dr. A. LEE and Professor K. PEARSON.

'The Cuckoo's Egg': OSWALD LATTER.

'Variation in *Aurelia*': E. T. BROWNE.

'Inheritance of the Duration of Life and the Intensity of Natural Selection in Man': Miss M. BEETON and Professor K. PEARSON.

'Artificial Selection, being a Comparison of the Distributions of Conscripts and Recruits in various Italian Provinces': Professor W. F. R. WELDON.

'Results of Cooperative Investigation on the Laws of Inheritance in Plants. I. The Shirley Poppy.'

'Variation and Correlation of the parts of the Human Skull. A Quantitative Study of the Naqada Crania': Miss C. D. FAWCETT.

'Extended and Improved Tables of Probability Integrals': W. F. SHEPPARD.

'Variation in the Form of the Helix of the Shell in *Clausilia laminata* (Montagu)': Professor W. F. R. WELDON.

'Mathematical Contributions to the Theory of Evolution. XI. The Influence of Natural Selection on the Variability and Correlation of Characters': Professor K. PEARSON.

'On a Physico-statistical Theory of Heredity': G. U. YULE.

'A Statistical Study of the Wild Bee': Professor F. Y. EDGEWORTH.

AN Index to the *Experiment Station Record*, covering the first twelve volumes, and containing more than one hundred thousand entries, has been prepared and will probably be published in the autumn.

THE Senate of the University of London has decided to publish periodically an official organ, to be called *The London University Gazette*, which will contain class lists, new regulations, dates of examinations, etc. The paper will appear about twenty times in the first year, beginning in October.

DISCUSSION AND CORRESPONDENCE.

THE VISUAL PERCEPTION OF SPACE.

THE fact to which Professor Thorndike called attention in the last number of SCIENCE must appear extraordinary to those who have not

considered the senses from the point of view of psychology. The ordinary man tends to regard our perceptions as copies or models of an outside world. The sense organs intervene, of course, and knowing that in vision the rays of light form an image on the retina, one is likely to think of the mind as viewing this picture from behind. As Professor Thorndike remarks, if one walks toward a chair, the apparent size of the object does not alter—at least not greatly or obviously—although the image on the retina becomes smaller. As I lecture to my class, the retinal images of the heads of the students on the back seats may be only one-tenth the size of those in front, yet they look only slightly smaller. But this is by no means the only disparity between the image on the retina and my perception. To begin with, the image is upside down and there are two images. Then the corners of my desk look like right angles, although they are by no means such in the pictures. I know by experiment that I can at one time have a distinct image of only one of the nearer heads, yet in my perception all the heads are distinct. A photograph in which very near and comparatively distant objects are included will in its distortion of perspective and blurring give some idea of what the image on the retina is like and how different it is from the perception.

Some of these facts were known to Berkeley, who in his 'New Theory of Vision,' first published in 1709, argues that visible objects are a system of arbitrary signs. In regard to apparent magnitude he writes:

> When we look at an object, the tangible figure and extension thereof are principally attended to; whilst there is small heed taken of the visible figure and magnitude, which, though more immediately perceived, do less sensibly affect us, and are not fitted to produce any alteration in our bodies.
>
> 60. That the matter of fact is true will be evident to any one who considers that a man placed at ten foot distance is thought as great as if he were placed at a distance only of five foot; which is true, not with relation to the visible, but tangible greatness of the object: the visible magnitude being far greater at one station than it is at the other.

Professor James, as always, discusses the matter admirably. He says ('Principles of Psychology,' II., 179):

> When the object by moving changes its relations to the eye the sensation excited by its image even on the same retinal region becomes so fluctuating that we end by ascribing no absolute import whatever to the retinal space-feeling which at any moment we may receive. So complete does this overlooking of retinal magnitude become that it is next to impossible to compare the visual magnitudes of objects at different distances without making the experiment of superposition. * * * As I look along the dining-table I overlook the fact that the farther plates and glasses *feel* so much smaller than my own, for I *know* that they are all equal in size; and the feeling of them, which is a present sensation, is eclipsed in the glare of the knowledge, which is a merely imagined one.

Professor Newcomb recently called my attention to the paradox that while we are

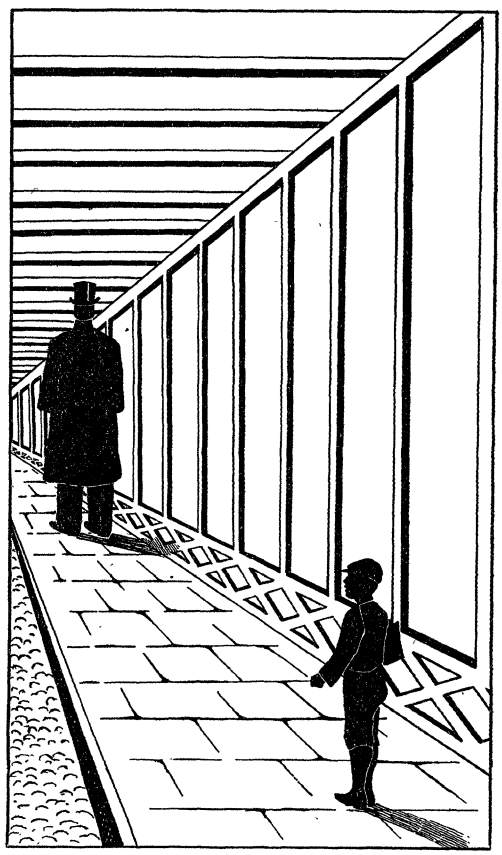

FIG. 1. The man and boy are of the same size.

said to judge the distance of objects of known size by the angles they subtend, our

perception of distance is more accurate than our perception of the visual angle. Owing to the fact that we must commonly ignore the visual angle in order to get useful perceptions, our interest in it is small and our knowledge vague. The moon, for example, always subtending the same angle, looks much larger at the horizon than at the zenith. If the reader is asked whether the little finger if held before the moon will cover it, he will probably say 'No,' or else hesitate to answer. As a matter of fact, the little finger covers the moon, and when it is removed we have a further illustration of the subject in the fact that the moon appears decidedly reduced in size, owing doubtless to a vague comparison with the finger.

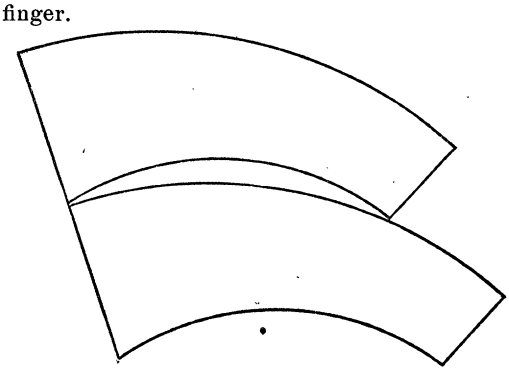

FIG. 2. The upper and lower areas are of the same size and shape.

I have made a few experiments on the accuracy with which the retinal area or visual angle can be judged under different conditions, and on the relation between the geometrical magnitude and the perception, and hope to continue them, though it is difficult to obtain quantitative results. The phenomena can be studied to advantage with the aid of mirrors, and it appears that data of interest can be secured by a consideration of photographs and of paintings and drawings. This I may illustrate by reproducing a figure from Professor Münsterburg's 'Pseudoptics,' in which the figures of the man and boy are of the same objective size.

While our ability to compare the retinal magnitude of objects at different distances and in different directions is very defective, the perception of visual magnitude when objects are side by side is perhaps the most accurate of all the senses, a difference of one-hundredth being noticeable. Yet even in this case the retinal area yields readily to suggestion as is shown by the accompanying figure, in which the two areas are of exactly the same size.

In a recent paper,* I have described what seems to me one of the most striking disparities between our perceptions and the physical world —no less than the perception of order in time as extension in space. If, for example, first a green and then a red surface pass rapidly behind a narrow slit, one does not see green followed by red, but simultaneously a surface with green below, white in the middle and red fading into black above. Physiologically we have a retinal process, consisting of a certain commotion caused by green light, lasting say 1/20 sec., then a mingling of this process with that excited by red, then that excited by red gradually subsiding. But this time series is perceived as a spatial continuum, and the field is, perhaps, three times as large as the window through which it is seen. If three squares, as shown on the left of the figure, are seen as they pass the window WW', they do not appear one after the other, but are seen simultaneously as indicated to the right.

This conversion of a time into a space order is also what always happens in ordinary vision. If the eye moves so that the line of sight moves

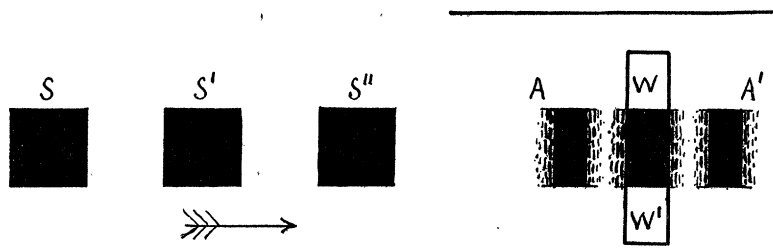

FIG. 3. The squares at the left appear as shown at the right when seen as they pass the window (WW') of the size indicated.

* 'On the Relation of Time and Space in Vision,' *The Psychological Review*, **7**: 325-343, 1900.

over a row of fifty books, each retinal element is excited in succession by each book, but we do not see one book taking the place of the other, but all the books side by side. Further, when the eye sweeps over fifty books in 1/10 sec., each book is seen, or appears to be seen, with perfect distinctness, though if the books moved at the same rate over the eye they would completely fuse together. Our perceptions in no wise correspond to the physiological processes in the eye, but are what they should be for our safety and convenience.

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CIRCULAR OF INFORMATION IN REGARD TO THE CAUSATION AND PREVENTION OF MALARIAL FEVER.

Recent investigations have shown that malarial fever belongs to that class of diseases which require for their transmission the active intervention of a definite kind of mosquito, *i. e.*, *Anopheles*. This genus is not the common one of this region, but is nevertheless present in many localities.

The organism causing malarial fever (*Plasmodium malariæ*) is probably a true parasite, and, so far as we know at present, finds the conditions necessary for its existence only in the living human body and in this genus of mosquito, the latter becoming infected by sucking the blood from an infected human being. The malarial organism having thus entered the stomach of the mosquito, passes through certain changes in the body of the infected insect, and at the end of about ten days reaches the poison gland. After this time, if the mosquito bites another human being, the malarial organism is introduced into the circulation of the latter and malarial fever follows.

So far as we know certain localities are 'malarious' only because they furnish favorable conditions for breeding this mosquito. Malarial fever would not occur in any malarious district, unless some infected human being were in it, or came into it and infected the mosquitoes, which in turn infected other human beings.

Recent observations in the intensely malarial districts in Italy and Africa have shown that even newcomers in these regions who purposely expose themselves by living in the most highly malarious area, for example the Roman Campagna, do not develop malarial fever, if they are carefully protected from the bites of mosquitoes; and further, it has been shown that this disease may be produced with certainty in any locality if a mosquito of the genus *Anopheles* is allowed to bite a person suffering from malarial fever and then, after a sufficient time, is allowed to bite a healthy person.

Certain simple precautions suffice to protect persons living in malarial districts from infection:

First.—Proper screening of the house to prevent the entrance of the mosquitoes (after careful search for and destruction of all those already present in the house), and screening of the bed at night. The chief danger of infection is at night, inasmuch as the *Anopheles* bite mostly at this time.

Second.—The confinement and continuous screening of persons in malarial districts who are suffering from malarial fever, so that mosquitoes may not bite them and thus become infected.

Third.—The administration of quinine in full doses to malarial patients to destroy the malarial organisms in the blood, and persistence in the use of the remedy even for a few weeks after apparent recovery.

Fourth.—The removal of the breeding places of the mosquitoes through drainage, filling up of holes and surface pools, and emptying of tubs, pails, etc., which contain stagnant water. These mosquitoes particularly breed in surface rain pools and surface stagnant water, where there are no fish; also exceptionally in pails, tubs, barrels and tanks of standing water, though they seem mostly to prefer natural accumulations.

Fifth.—In pools which cannot be drained or filled, the destruction of the mosquito larvæ by the use of petroleum thrown upon the surface, by the introduction of minnows and other small fish which eat the larvæ, or by both methods.

These measures, if properly carried out, will suffice greatly to restrict and largely to prevent the occurrence of new malarial infections.